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A New Automatic Nonrebreathing Valve

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Although numerous automatic nonrebreathing valves have been introduced into clinical anesthesia during the last few decades, various problems encountered in their clinical use remain to be resolved. For instance, valves with rubber mushrooms at the exhalation orifices (*e.g.*, Fink and Frumin valves) tend to hinder the flow of exhaled gas when pressure caused by excessive gas inflow the anesthetic machine is built up on the reservoir side of the nonrebreathing system. A disadvantage of the Ruben valve is that 10 to 76 per cent of the exhaled gas leaks back to the reservoir side of the system during exhalation when the pressure applied to the bag is released in the conventional manner.

The authors tried to reduce or eliminate the major disadvantages of these valves and after repeated trials developed an automatic nonrebreathing valve with several advantageous performance characteristics.

The valve* is shown in figure 1. It has minimal mechanical deadspace, low respiratory resistance and no leakage of exhaled gas back into the reservoir bag.

As shown in figure 2, the valve consists of two major chambers. There are three valve discs A, B and C. The inferior space is divided into inspiratory and expiratory sides by the inspiratory valve discs A and B.

Disc B is a thin membraneous flap kept in the central portion of A by a weak coil spring, and closing the gas inlet channel through disc A in the resting state. A and B together operate as a check valve so that there is unidirectional gas flow.

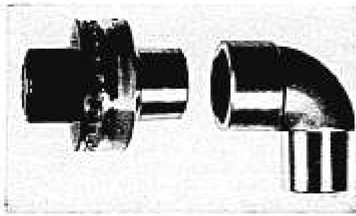

FIG. 1. Hirano valve and angle piece.

Doughnut valve C closes the expiratory orifice during inspiration. During expiration, valve C is opened by the pressure produced inside the exhalation chamber by exhaled gas, and the gas escapes through the orifice. The exhalation orifice consists of numerous holes about 3 mm in diameter.

The outer diameter of the valve is made to fit the opening in an ordinary face mask, and the inner diameter is made to insure a snug fit with a 15-mm slip joint of an endotracheal catheter.

The valve allows no back-leak for the following reasons: when the pressure applied to the reservoir bag is released at the end of inspiration, the inspiratory valve discs (A and B) close off the inspiratory orifice by the spring before the commencement of expiration. Moreover, the expiratory gas flow forces the valve discs (A and B) against the inspiratory orifice. At least theoretically, "back leak" of the exhaled gas into the reservoir side of the valve

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* Manufactured by Igarashi Ika Kogyo Co. Ltd. #25-2, Hongo 3-Chome, Bunkyo-Ku, Tokyo, Japan 113.

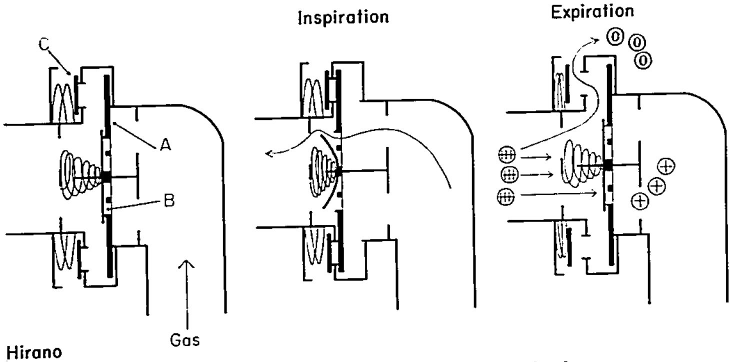

FIG. 2. Structure of the valve and the action of the valve discs.

cannot occur with this valve, irrespective of the manner of pressure release applied to the reservoir bag.

The actions of the valve discs are illustrated in detail in figure 2.

The valve also has a low respiratory resistance. The resistances to both inspiratory and expiratory gas flows through the valve are compared with those in Fink and Ruben valves in figure 3.

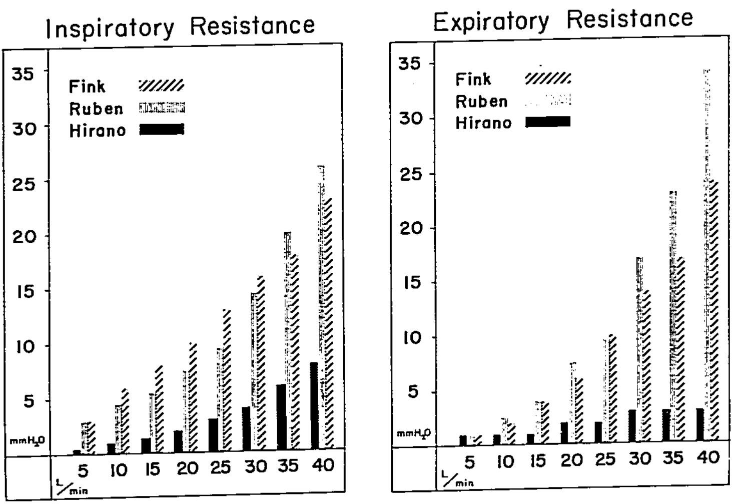

FIG. 3. Inspiratory and expiratory resistances of three valves to various flow rates of oxygen. Abscissa: flow rate of oxygen through each valve. Ordinate: pressure built up at the inflow side of the valve by the oxygen flow.